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IMPACT ANALYSIS OF OFF-ROAD-VEHICLE USE ON VEGETATION IN THE GRAND MERE DUNE ENVIRONMENT[1]

Ger Schultink
Remote Sensing Project
Michigan State University
East Lansing, MI 48824
(517) 353-7195

ABSTRACT

Concerns have been expressed relative to the impact of man on the Grand Mere area. Remote Sensing input was requested as a means of quantifying aspects of the impact and for deriving crucial information for the development of appropriate planning guidelines and management programs. Up to date, 70mm color aerial coverage was acquired (scale 1:14,000).

The impact of Off-Road-Vehicles (ORV's) was specifically studied in terms of subsequent erosion and vegetation damage.

Time comparative analysis was carried out for 2 sampling sites, selected according to previously defined criteria. The vegetation cover was delineated for these sample areas and the percent vegetative cover was calculated using a standard dot grid. Linear regression between vegetation cover and the time variable showed an average vegetation loss for sample area #1 of 1.901% per year and for sample area #2 of 5.889% per year.

Extrapolation of these recession rates justifies the prediction that complete loss of vegetation will occur in a relatively short period; for example, area #1 (± 14.4 hectares) in 33.5 years or for sample area #2 (± 16.8 hectares) in 8.3 years.

Relative recession ratio for the specific sampling area show clearly the influence of the energy crisis on ORV use in the period 1973-1974.

Current legal action is being taken to prevent further deterioration of the Grand Mere Complex.

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Introduction

The Grand Mere area, consisting of approximately 1,000 acres, situated along the shore of Lake Michigan (Berrien County), represents one of Michigan's few remaining unique dune environments. This uniqueness is based on a variety of present ecosystems like streams, bogs, lakes, wooded uplands, open beaches and dunes. The great diversity in ecosystems exhibited by the complex is the result of a long evolutionary process, taking place within a rather isolated area, leading toward a delicately balanced and dynamic ecological complex. The lakes and bogs illustrate various stages in succession, from aquatic to terrestrial plant communities. In addition to the wide range of plants typical of these communities, select species, rare in Southern Michigan, are found. Sand dunes and upland forest provide an essential buffer protection for these micro-environments.

There exists an increasing awareness of the ecological value of inland wetlands. Recent studies have indicated the significance of wetland ecosystems in contributing to water quality, water quantity, productivity and potential educational use (Wharton 1970). Odum (1959) estimates that the gross production of southern river swamps compares favorably with highly productive, intensively managed agro-ecosystems like sugarcane. Some wetlands are essential as actual breeding areas for waterfowl. Others are more important as wintering grounds or as feeding and resting areas along major flyways (Errington 1966, Niering 1966). This last aspect plays an important role in the Grand Mere Complex.

Oxygen production and nutrient recycling capabilities of wetlands are emphasized by Grant and Patrick (1970). The increasing role of non-point sources in environmental pollution in the agricultural areas of the Midwest, and the nitrogen compounds produced as by-products of industrial processes and automobiles, have made the denitrifying and sulfate-reducing capabilities of aquatic ecosystems even more essential.

A multiplicity of activities have placed wetland ecosystems in jeopardy. Dumps, sanitary land-fill operations, highway construction, draining and filling for new developments have all affected the nutrient balance and ground water table and therefore severely threatened the future existence of such essential habitats for flora and fauna.

These encroachments have taken place in the Grand Mere area as well. Limited timber cutting in the past and increased recreational activity by off-road vehicles has caused accelerated erosion of the dune complex. The potential eolic deposits of dune sand in the lowlands behind the dunes have created an imminent environmental threat. In combination with this fact, the potential for surface sand mining exists for about 60% of the area which is currently privately owned.

The Grand Mere Association, a group of people dedicated to the preservation of this unique environment, has been concerned with the impact of man on the Grand Mere area in terms of land use changes of portions of the area or adjacent buffer zones and the impact of recreational activities. A major problem expressed by the Grand Mere Association is the impact of off-road vehicles (ORV) on vegetation resulting in accelerated wind and water erosion

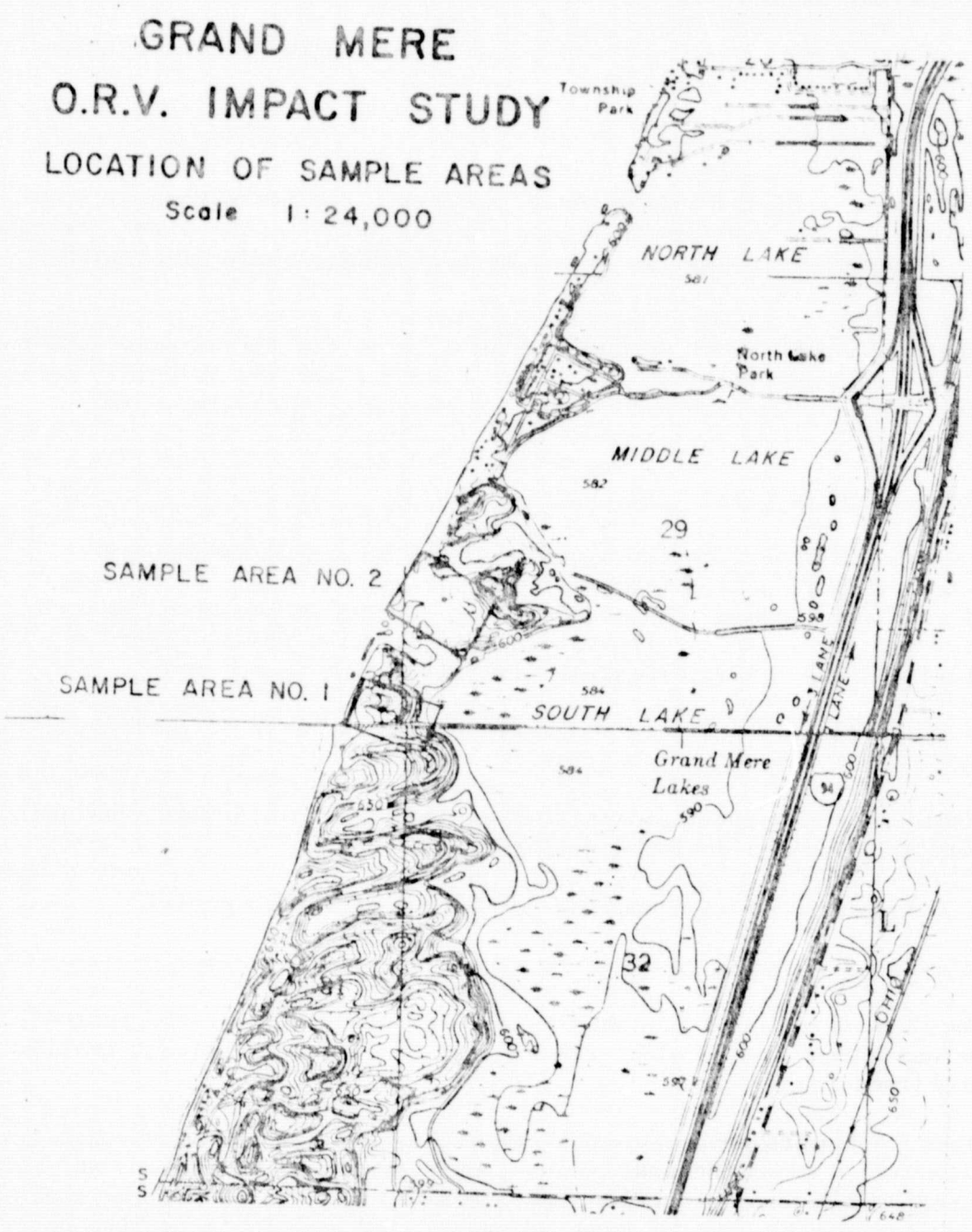

Figure 1.--Map of the Grand Mere Area With Location of Sample Areas.

affecting plant and animal life. To develop appropriate management decisions for control of this activity, however, this impact had to be quantified. In Fall 1976, the MSU Remote Sensing Project was requested to provide evidence of the impact of ORV use on vegetation.

Data Sources

In order to acquire up-to-date aerial coverage, the Grand Mere area was flown in October 1976 by MSU Remote Sensing Project staff. The photo coverage consisted of 70mm color transparencies at an approximate scale of 1:14,000 (1 inch = ± 1.221 mile).

The subsequent cibachrome prints (1:6,000) from this flight were used to delineate current vegetation boundaries. As a source for the 1970-1975 period Michigan Department of Natural Resources' B/W Photography (scale approx. 1:5,000) was used.

Time Comparative Analyses

The area most affected by ORV use is located in the Dunham Dune area situated between Middle Lake, South Lake and the Lake Michigan shoreline, immediately south of Grand Mere Beach (see Fig. 1, map of the Grand Mere area). The reason for this is clear since this location provides easy access from I-94 and adjacent residential developments.

A number of sample areas were selected within this area to evaluate ORV impact, based on the following criteria:

1. Selection of areas with identifiable reference points that remained unchanged over the entire sampling period.

2. Selection of areas with varying degrees of access potential.

3. Maximize sample size in order to reduce statistical sampling error.

4. Selection of areas of variable relief representative of the rest of the Grand Mere area, rather than specific highly significant erosion areas.

With this in mind, two sample areas were chosen (Fig. 1). The vegetative cover over the period 1970-1976 for these sample areas was delineated and the percent of vegetative cover versus barren areas was calculated for these samples using a standard dot grid (256 dots/inch^2). Table 1 indicates the percent of non-vegetative land for sample areas over time.

Results

Based on the figures in Table 1, a linear regression between percent non-vegetative land and the time variable (period 1970-1976 with increments of one year) was completed for the two sample areas.

Sample Area #1 shows an average vegetation loss of 1.901% per year ($r = 0.98569^*$), while the loss for Sample Area #2 amounts to 5.889% per year

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*1% significance level

(r = 0.96450*). Two basic reasons for this difference can be assumed to play a role, namely, the difference in access potential and the amount of already fragmented vegetation complexes in existence during the first year of the comparative analysis--1970. Sample Area #2 is located closer to potential access points and was more fragmented initially.

TABLE 1.--Percent Non-Vegetated Land in Sample Areas.

DATE	SAMPLE AREA #1**	SAMPLE AREA #2**
Oct. 76	33.557	51.190
Oct. 75	30.920	42.850
Oct. 74	30.307	***
Nov. 73	28.571	39.687
Oct. 72	24.814	22.558
Nov. 71	22.996	21.184
Nov. 70	22.182	16.195

** Percentage non-vegetated
*** Complete coverage not available

Furthermore, locally existing micro relief determines to a great extent the potential impact of recreational vehicles. Very steep slopes will limit vehicle activity to a point in time when natural erosion processes make these slopes again accessible to ORV use.

Table 2 indicates the relative increase in vegetation loss per year for the sample areas.

TABLE 2.--Relative Percentage Vegetation Loss During Indicated Sample Period.

PERIOD	SAMPLE AREA #1**	SAMPLE AREA #2**
1970-1971	3.54	23.55
1971-1972	7.33	6.09
1972-1973	13.15	43.16
1973-1974	5.73	3.69***
1974-1975	1.98	3.69***
1975-1976	7.86	16.30

** Relative percentage vegetation loss
*** Averaged relative percentage vegetation loss over two year period 1973-1975.

*1% significance level

These computed values, based on the percent of non-vegetative land, are illustrated in the bar graphs for the two sample areas (Fig. 2 and Fig. 3).

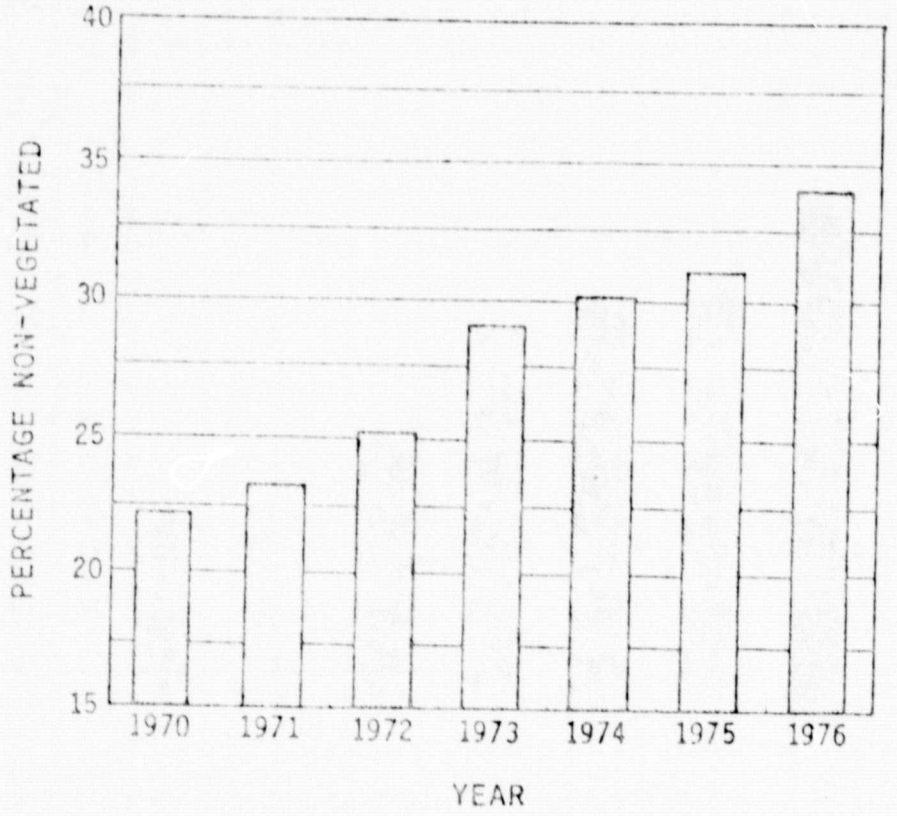

Figure 2.--Percent of Non-vegetated Land in Sample Area #1: 1970-1976.

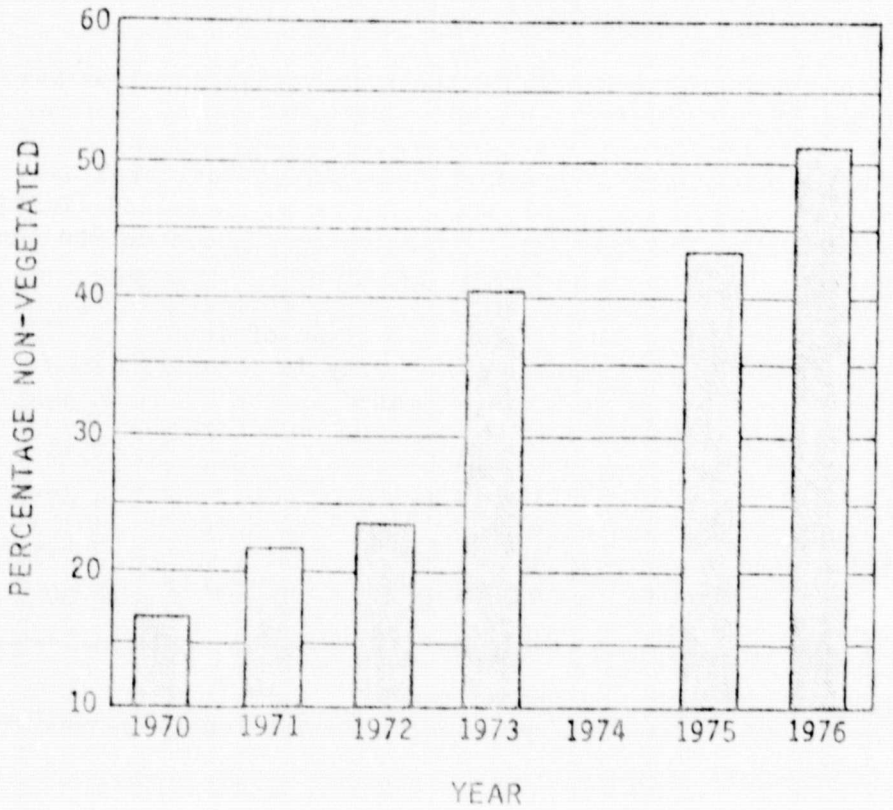

Figure 3.--Percent of Non-vegetated Land in Sample Area #2: 1970-1976

For both sample areas, the highest relative percent vegetative loss occurred in the 1972-1973 period. As a contrast, the 1974-1975 period shows the smallest relative loss. A possible explanation for this significant contrast might be the fact that gasoline became, at least temporarily, a scarce commodity and that gas prices went up considerably, especially during the energy crisis created by the oil embargo.

The main conclusion of the time comparative analysis is that vegetation loss due to ORV use will continue to exist in spite of gasoline price fluctuations. Based on the computed values of 1.981% and 5.889% annual vegetation loss, the prediction is justified that all vegetation will be lost in 8.29 years for Sample Area #2 and in 33.54 years for Sample Area #1.

These predictions may even be rather optimistic for two reasons. First, it might be assumed that, in general, if the amount of remaining vegetative cover decreases, the rate of loss will increase. Secondly, areas most affected by ORV use will turn into non-vegetated, sandy environments with relatively high temperatures in summer periods. The lack of vegetation cover will increase surface wind intensities and, consequently, increase the potential for wind erosion. These factors will tend to move peak recreational pressures to areas which are more shielded in a micro-climatic sense and cause an accelerated recreational impact on those locations within the sample area.

In the regression model, however, the extrapolation is based on an assumed linear relationship between the two variables. If a curvilinear relationship would be substituted allowing for an increased rate of vegetation loss, ORV impact will have been under predicted. Thus, complete vegetation loss for specific areas will occur in less than 8.29 and 33.54 years, respectively.

Recommendations

Since the analysis has indicated how severe ORV impact is in the Grand Mere area, alternative management considerations are urgently needed to limit or restrict recreational vehicle use. Recent experiences with blocking local access paths have proven to have only a limited effect on ORV activity. The capability of these vehicles to circumnavigate a major access-limiting structure has simply caused the destruction of vegetation adjacent to those structures.

The overall impact and mobility of this type of intensive recreation makes it very clear that this land use activity is incompatible with the unique character of the ecosystems represented in the Grand Mere area. It has therefore been recommended that ORV use be immediately terminated in the area currently owned and managed by the State of Michigan and the Kalamazoo Nature Center. Furthermore, similar policies and guidelines, developed in cooperation with agencies and private owners of current and potential Grand Mere property, are urgently needed to prevent further decay of present ecosystems. If any doubt exists about the safeguarding of specific areas in this respect, then those areas having the highest priority of future acquisition and/or alternative management policy considerations should be selected.

A coordinated effort has to be made by all the management and planning agencies involved to create an alternative location for ORV use. The most

appropriate alternative seems to exist in those areas destined for sand mining in the very near future or those sand mining areas recently abandoned. In this respect, a number of alternative sites south of the Grand Mere complex, e.g. the Bridgman area, are recommended.

The severe impact potential of ORV use on the dune environment of the Grand Mere area should clearly justify any coordinated action to expell this recreational activity from the Grand Mere area.

Based on these recommendations, township authorities, along with the Grand Mere Association, have joined forces to restrict ORV use in the Grand Mere area. Three roads near entrances to the Grand Mere Complex have been closed to traffic by the township board, and township police have been instructed to enforce the new regulations for ORV use. Extra funding has been provided to the police budget for intensified patrols in the area. As a result of these actions more than 200 traffic citations were issued in the spring of 1977, and ORV's have become a rare species.

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